Review of A.C. Crombie, *Styles of Scientific Thinking in the European Tradition: The History of Argument and Explanation Especially in the Mathematical and Biomedical Sciences and Arts*,

Duckworth and Co, 1994, 3 vols, pp. xxxi + 2456

by Michael Redhead, Wolfson College, Cambridge

In this monumental work, Crombie develops the history of the European scientific tradition from its origins in ancient Greece to the middle of the ~~nineteenth~~ 19th century. The distinguishing feature of this study is that it concentrates exclusively on the history of argumentation and methodology, so it is really a work in the history of philosophy of science rather than in the history of science as such. It does not encroach very much on general intellectual history, the history of ideas as it is often called, but keeps a strictly narrow focus on specifically scientific ideas and arguments. It is also very largely on internal history paying very little attention to the wider context of external social and economic ~~conditions~~ factors. In this sense the book has an oddly old-fashioned feel about it. Indeed much material from earlier books by Crombie, such as *Augustine to Galileo* (1952) and *Robert Grosseteste and the Origins of Experimental Science* (1953) to mention two of his most famous works, is ~~are~~ now integrated and greatly expanded in the new magnum opus.

[Another feature of the book is that it is almost

entirely descriptive and makes no attempt to evaluate the styles of reasoning described or to relate the historical^{200} material to contemporary discussions in philosophy of science. Crombie provides essentially an enormous wealth of examples of how scientific arguments have been presented and attempts an interesting taxonomy, to which I shall return in a moment. But he writes strictly as an historian, not as a philosopher. It is perhaps a pity that he breaks off the story, with the example of Darwin and evolutionary theory. So ~~the~~ the fascinating issue of styles of reasoning in 20th ~~twentieth~~ century theoretical physics, for example, and how these are related to those employed in classical physics, is not touched on at all.

[But within these^{300} self-imposed limitations what sort of story emerges from Crombie's hugely erudite work, about the emergence and development of Western science? He identifies the ~~key~~ crucial turning point here with the development amongst the ~~6th century~~ Ionian Greeks in the 6th century BC of the concepts of proof and causality. From general principles or postulates, all natural phenomena could be 'deduced' in the style of a proof in geometry, the explanation of phenomena arising from 'a universal causal order, causes necessitating effects in a way that 'paralleled the relation of axioms and theorems' in the characteristic Greek approach to mathematics. Logos replaced Mythos in$^{(400)}$ a rational natural philosophy!

Crombie sees this as the unique achievement of the Greeks. In Babylonia, Egypt, Assyria ~~and~~ India and China there were many remarkable achievements in mathematics and technology, but the idea of comprehending specific results in a general postulational framework seems to have been entirely lacking in these other civilizations.

[Of course there was much variety in Greek natural philosophy. The ancient atomists envisaged a Universe of swirling configurations of eternal changeless units, the atoms, as underlying all physical change. These doctrines were the direct ancestors of the mechanical Cartesian philosophy of the 17th century. There were also 500 the ancient sceptics, who denied the very possibility of human true knowledge or understanding of the natural world. These arguments were influential in the medieval discussions concerning the inscrutability of God's design for the Universe, and lead in a natural way to the positivism, antirealism and instrumentalism, so familiar in the present century. Science always walks a tight-rope, delicately balancing itself between conjectural explanatory claims and the admitted fallibility of its theorizing. But certainly at the methodological level some degree of confidence in obtaining objective truths about the world seems necessary for scientific progress. This was the characteristic attitude 600 of the pioneers of the scientific revolution in the 16th and 17th centuries, of men like Galileo and Kepler and Descartes and Newton (~~despite their~~ his sceptical disclaimers), ~~which belied their practice~~

Newton, of course, famously denied making 'hypotheses', and tried to give the impression ~~that~~ of deducing his theories directly from the empirical phenomena. This he patently failed to achieve, but the important point to note here is that Newton was following ~~on~~ the Pythagorean-Platonic ideal of arriving at the mathematically describable harmonies in the natural world, rather than what he regarded as the 'profitless' attempt on Aristotelian lines to discover the essential and metaphysically ultimate nature of matter, light 700 gravitation and so on. This emphasis upon the quantitative versus the qualitative, and the essential role of mathematics in the physical sciences has been one of the vital key ingredients of Western science. But it is not the whole story, so I will now turn to Crombie's 'attempt at a general classification of scientific styles of reasoning. [First of all there is the method of postulation, to which ~~as~~ I have already referred. This was particularly appropriate to the mathematical sciences, such as astronomy and mechanics. But even here there was a role for observation and experiment as a control on theoretical 800 postulation, for example by checking observable consequences. But in more complex subject matters the role of experiment became increasingly important, when purely theoretical investigations from an ~~an~~ 'a priori' standpoint was out of the question. Here the method of analysis and synthesis or resolution

and composition as it was called by the scholastics, the 'experimental analysis of phenomena', distilling the few underlying principles and 'then synthesising its explanation of other phenomena' so validating the correctness of the analysis by the variety of the synthetic explanations and predictions. Of course mere passive observation was quite different from experimentation in which, as Crombie puts it[900] 'nature is seen' in the image not so much as an open book as of an unknown alphabet to be found out and mastered or of a quarry to be sought and hunted down, or of a dark labyrinth through which science had to feel its way or follow a thread, or of a mysterious wanderer whose footprints it had to trace, or of a workshop whose hidden operations it had to uncover by apprenticeship, or of an opaque body it had to dissect layer by layer, or to a guileful and recalcitrant witness it had to interrogate by torture[1000] to yield up its secrets in order to argue a case'. I have given this quotation at length because it is pretty characteristic of Crombie's somewhat loquacious prose style, but nevertheless striking and effective in its choice of a telling phrase or a ~~striking~~ potent image.

[The next method Crombie describes is the method of hypothetical modelling in which the properties of some artefact designed and produced by ourselves is used to simulate, and in an

analogical sense to explain, unknown aspects of natural phenomena. A striking example here is the use of the Camera Obscura to elucidate the mode of ^{1100} operation of the eye, as expounded by Giovanni Benedetti in the 16th century.

[Another quite distinct style of reasoning ~~was~~ was the taxonomic method used in biology and medicine to classify the huge variety of plants, animals and diseases by systematic comparison and differentiation. Originating in Greek science with Aristotle, Theophrastus, Hippocrates and Galen, Taxonomy involved both the practical problem of naming and ordering ~~animals plants~~, and also theoretical disputes on how to distinguish real affinities from merely nominal ones. This is the style of reasoning which sees science as glorified stamp collecting.

[The next method that Crombie identifies is the method ^{1200} of statistical analysis and the calculation of probabilities. This enabled explorations of regularities under conditions of contingency and uncertainty with respect to individual members of a population. This raises at once the question of whether the uncertainties are epistemic or truly ontological in character, the most famous protagonists of those two positions in antiquity being Democritus and Epicurus respectively.

The mathematical developments in the 16th century by Blaise Pascal, Pierre Fermat and others, ~~th~~ arising from practical problems of calculating odds in games

Insertion
to the work of Lambert - Adolf - Jacques
Quetelet and

of chance led to the ~~elaborate~~ powerful combinatorial approach elaborated by Jakob Bernoulli, Abraham de Moivre, and 1300 Pierre-Simon de Laplace in the 18th and early 19th centuries. Probability was also applied to ~~the~~ important question of analysing and attempting to reduce the effect of random errors in experimental measurement. At the same time ~~Cor.~~ ~~Anot~~ Antoine-Nicolas de Condorcet was extending the analysis of probabilities to a new science of human society which in turn was to lead directly* to Thomas Malthus and his famous *Essay on the Principle of Population*. These developments were to react back ~~influence~~ on physics again with the rise of the kinetic theory of gases in the middle of the 19th century.

[The final style of reasoning discussed 1400 by Crombie is the method of historical derivation or the genetic method seeking to explain similarity and diversity in areas such as linguistics, geology and biology in terms of historical origins and principles of development. The most prominent example here is, of course, the theory of evolution by natural selection as 1450 expounded by Charles Darwin in ~~the~~ his *Origin of Species* ~~first~~ published in 1859.

[This brief exposition of the six styles of reasoning investigated by Crombie in no way does justice to the enormously informative number of examples and quotations provided in this work. Apart from some 250 pages of notes 1500 to the main text, there are 600

Insertion/

is argued by philosophers today just as it was by the ancient Greeks pages of references in the bibliography. The coverage is indeed remarkably complete. ~~although there are a few surprising omissions, for examples Against Proclus by ~~Johannes~~ Joannes Philoponus is not~~ listed, ~~nor is the famous text of Philodemus On Inference which gives the standard epicurean view on evidence.~~

[The way in which Western Science had to compete with rival world-views such as the Hermetic tradition, alchemy and natural magic is very well brought in Crombie's book, but ~~and~~ just when reason seemed to triumph over superstition and mysticism in the 18th century Enlightenment, the reaction of the Romantic movement and the obscure excesses of Naturphilosophie renewed the complex dialectic of intellect & and ~~emotion~~ intuition at 1800 the beginning of the 19th century. Surprisingly Crombie makes no mention of this and indeed Naturphilosophie is not even listed in the index.

Better dealt with is the changing conception of human beings in relation to the physical Universe and the relations between ~~of~~ science and religion, a complex ~~interplay~~ dialectic that played a crucial role during most of the period covered in this book. ~~1668~~ 1670

[The rise of Western science shows the ingenuity of human beings in confronting the apparent complexity of Nature with an apparent underlying simplicity and order. To what extent this has reflected 1700 objective progress ~~in~~ towards the truth or is merely the expression of overweening hubris is ~~no more~~ + ~~settled today than it was by the presocratic~~

Insertion *

Crombie's book throws no light on this fundamental dispute from the philosophical point of view, but it is nevertheless

* ~~Ionian philosophers who started it all.~~

~~Crombie's book is~~ a work of rare scholarship, ~~although~~. It is perhaps doubtful whether ~~that~~ many people, ~~other~~ apart ~~than~~ from book reviewers, will struggle ~~through~~ to ~~the end~~ read the whole of this stupendous book. But anyone who merely skims or dips into it will miss out on many curious examples and rich insights. I urge the intending reader to persevere.

1786